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SOLVENT RECLAMATION PROJECT

FINAL REPORT

INDUSTRIAL WASTE DIVERSION PROGRAM

NOVEMBER 1996

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SOLVENT RECLAMATION PROJECT

FINAL REPORT

INDUSTRIAL WASTE DIVERSION PROGRAM

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Waste Reduction Branch
Ontario Ministry of Environment and Energy

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INDEX

i. **Abstract**

1. **Introduction**

2. **Factors Involved in Equipment Selection**

3. **Cost Analysis and Projected Savings**

8. **Purchase and Implementation of the System**

10. **Design of the Recovery Process - Floorplan**

11. **Purity Analysis**

16. **Comparison of Projected and Actual Reductions Achieved**

19. **Final Analysis - Conclusions**

Appendix A - Solvent Usage and Waste Production Analysis

Appendix B - Floor Plan

Appendix C - Virgin and Reclaimed Solvent Comparison Report

ABSTRACT

Analysis of solvent usage and cost data, coupled with research into various solvent reclamation systems, led to the decision to acquire the LABMASTER DISTILLATION SYSTEM (Chemical Management Technology Inc.) as a means to:

1) recycle the large amounts of waste organic solvents produced by the Henderson Laboratory (primarily Anatomic Pathology and Haematology solvents)
2) reuse the recycled waste organic solvents in a continuous loop
3) reduce the volume of waste organic solvents to be disposed of
4) reduce the amount of virgin organic solvents (xylene, ethanol, methanol) being purchased by this laboratory
5) reduce the cost disposing of waste organic solvents.

The decision to acquire the Labmaster Unit was based on safety, performance, and compliance with Ministry of Labour regulations, Fire Code, Ontario Building Code, CSA standards and finally, suitability for placement in an existing Code I Explosion Proof Environment. Application was made to the Ministry of Environment and Energy's Program Development Branch for funding assistance under the Industrial Waste Diversion Program. Electrical renovations to the Explosion Proof Class I environment, in which the labmaster Unit was to be housed, were undertaken by a local outside contractor (Harbour Electric Limited). Part of the cost of the electrical installation was covered by the agreement with the Ministry of Environment and Energy. Plumbing renovations were undertaken by the Hospital Maintenance Department at the expense of the Hospital. The Labmaster Unit was Set-up and operational instructions were given by the CMT representative to the Chief Technologist and the Lab Porter on 14/06/94. Operation of the Labmaster Unit began on 21/06/94 with the reclamation of waste xylene.

Phase I of the project involved the reclamation of xylene, methanol and 95% ethanol waste. Phase II involved the reclamation of absolute ethanol waste and the use of the "Mermaid" molecular sieve to remove any remaining water, present as azeotropes, from the reclaimed ethanol in order that it could again be reused as absolute ethanol.

Since the implementation of the Labmaster Solvent Recovery System the Henderson laboratory has realized a 27% reduction in overall costs related to the utilization of xylene, methanol and absolute ethanol for the 1994 calendar year and projects a 43% reduction in costs in 1995. These percent decreases reflect an actual savings of $3,400.00 in 1994 and a projected annual savings of $5,560.00 in 1995, when compared to the annual costs averaged over the four previous calendar years. The amount of virgin solvents purchased in 1994 was reduced by 21% when compared to the annual amounts averaged over the previous four calendar years and is projected to be reduced by 42.5% in 1995 when compared to the same averaged figure. The corresponding amount of waste solvents disposed of in 1994 is reduced by 33% and a reduction of 55.6% is projected for 1995. A total of 3,477 litres of solvents have been processed through the solvent recovery system since its implementation. While the project did not unfold as originally planned, (ie. delays in delivery, modifications to recovery operation to compensate for solvent purity degradation, cost and supply of sieve material) the above mentioned reductions related to the purchase of virgin solvents and costs of disposal and transportation of waste solvents combine to successfully achieve the originally stated five goals of the project.

This report focuses on the various stages of the solvent recovery project undertaken by the Henderson General Laboratory. Details of the wastes diverted as well as a review of the successes and failures (deviations from the original plans) are discussed.

Introduction

Rising costs for virgin solvents combined with increasing costs for the safe disposal of waste solvents, at a time in our economy when it was becoming painfully obvious that decreased funds would be available for the operation of Health Facilities, were compounded by a heightened concern for the environment. These factors led, in January of 1994, to the investigation of a means to counter the above mentioned concerns.

It became evident, after studying the most current information in the recycling industry and analyzing the Henderson Laboratory Solvent Cost and Usage Data for a four year period (1990 through 1993), that major cost savings in the area of virgin solvent purchases and waste solvent disposal costs could be obtained by implementing a solvent reclamation system within the Henderson Laboratory environment. An obvious and welcome outcome of implementing such a system was the reduction of waste solvents released for disposal to the global environment.

The aims of implementing a Solvent Recovery System were therefore defined as:

Reduce the amount of waste solvents disposed of,

Reduce the amount of Virgin Solvents purchased,

Recycle the maximum amount of waste solvents possible and

Reuse as much of the Recycled solvents as possible.

Consideration was given to the safest and most efficient operation of the system. The system should provide sufficient recovered solvents, of sufficient purity, to perform routine daily operations. The capital outlay of the system should be recoverable within a reasonable time after commencement of full operations of the system. Renovation costs and implementation costs related to the system should be kept to a minimum. The system should be durable and long lasting.

At least two distinct and successful systems were available for the safe and efficient recycling of solvents such as xylene, methanol, ethanol, acetone and chloroform in 1993. The two leading systems on the market, at the time this project was being considered, were the Labmaster System, distributed by ESBE Laboratory Supplies (ESBE) for Chemical Management Technologies (CMT, Orange Park, Florida) and the B/R Solvent Recovery System, distributed by Canada 5 Medical for B/R Instrument Corporations System (Easton, Maryland). Xylene, ethanol and methanol represented the bulk of the virgin solvent purchases made by the Henderson Laboratory; purchases of these solvents accounted for a significant portion of the Anatomical Pathology Operating and Supply budget over the four years analyses.

Prior to purchasing a Solvent Reclamation Unit the Ministry of Environment and Energy was contacted to inquire as to the state of the Industrial Waste Diversion Program (IWDP). Specifically, this Lab inquired as to the possibility of being considered for grants under the IWDP. The proposal to the Ministry outlined the fact that a quantity of Waste Solvents has been identified as potentially recyclable and it was the intention of the Henderson Laboratory to attempt to recycle, reuse and therefore, reduce the amount of wastes produced by this laboratory in the daily production of investigative material from human sources.

Factors Involved in Equipment Selection

Although each of the previously mentioned systems were designed to be safely operated within the Laboratory environment, there was insufficient space available to locate a recovery system, and the accompanying waste solvent containers, within the Laboratory. This fact determined that the Solvent Reclamation System, if purchased, would be required to be housed in the current Flammable Storage facility, adjacent to the loading dock on the North side of the Hospital. Inspection, by an outside Architectural Firm (Vermeulen/Hind of Hamilton, Ontario), confirmed that:

"Upon review we find this room, in its current configuration, meets the requirements of Item 3.3.1.2 and Section 3.3.5 of the Ontario Building Code and Part 4 of the National Fire Code. Item 4.1.5.3 of the National Fire code requires portable extinguishers be provided in this room as per Part 4 and Part 6 requirements. Consequently we find this room is ideally suited to house the intended Solvent Recovery Unit".

The intended location of the Solvent Reclamation System, the Flammable Storage area, is a Class I environment, rated explosion proof. Therefore, any electrical units or fixtures operating in this environment are required to be CSA approved "explosion proof" in order to comply with Ministry of Labour regulations (O.H.S.A.). Discussions with Mr. Ian Beales, of the Industrial Health and Safety Branch of the Ontario Ministry of Labour, in the Spring of 1994 confirmed that operation of a Solvent Recovery unit in a Class I environment would be restricted to only those units which have obtained Special CSA Acceptance Labels for operating in a Class I, Group C or D hazardous location.

Further discussions with the distributors of each of the units previously mentioned revealed that only one of the units complied with the requirements of the Ministry of Labour for use in the Class I hazardous location. While the B/R System was highly rated by the distributor as well as the authors of "Hazardous Chemicals in the Histopathology Laboratory" (2nd ed., Anatech Ltd) it was determined that the B/R System would not meet Ministry of Labour Regulations for operation in a Class I environment.

A letter verifying the Classification of the Explosion Proof Room and a letter from Ian Beales of the Ministry of Labour, confirming the fact that the Labmaster Solvent Recovery System has qualified for CSA Special "Explosion Proof" approval are on file in

the Henderson Laboratory and are available for inspection.

The CMT "Labmaster" solvent reclamation system is constructed entirely of stainless steel for durability, distillate purity and to eliminate the potential hazards of glass components. The system possesses no less than fourteen (14) safety features including C.S.A. approved "Explosive Proof" construction and requires minimal operator involvement. The electrical requirements of the system are 240 volts single phase at a draw of 14 AMPS. The electrical requirements could be supplied to the Flammable Storage Room by qualified electricians.

A presentation by CMT was given in Toronto in February of 1994. The attendees had the opportunity to question the President of CMT with regards to all aspects of the Labmaster Solvent Recovery System. Concerns with regards to Recovered Solvent purity and the length of time any one waste solvent could be cycled through the recovery loop were addressed along with operator training and safety concerns. The responses to the questions, supported with documentation and verbal as well as written guarantees, supplied this investigator with enough information to warrant the purchase of the CMT Labmaster System.

The decision to acquire the Labmaster Unit was based on safety, performance, and compliance with Ministry of Labour regulations, Fire Code, Ontario Building Code, CSA standards and finally, suitability for placement in an existing Class I Explosion Proof Environment. The Labmaster System was purchased for $29,793.45 and the installation costs amounted to $1,706.00.

The following section of this report outlines the costs associated with the purchase and handling of virgin solvents over the four calendar years, 1990 through and including 1993, immediately preceding the decision to investigate possible cost savings.

The following section of the report also projects the cost and waste solvent volume reductions associated with the implementation of the Labmaster Waste Solvent Recovery System.

COST ANALYSIS AND PROJECTED SAVINGS

The costs associated with the use of solvents for the preparation of tissue samples and blood smears in the Henderson Laboratory are detailed in this section of the report. The analysis includes the costs of purchasing virgin solvents, disposing of the waste solvents produced and transportation costs for returning empty drums.

Anhydrous Ethanol is used as the principal dehydrating agent in the processing of tissue samples in the Anatomic Pathology Lab. It is also the principle ingredient in the fixative used in Cytopathology. Ethanol is purchased in 210 L drums. A drum deposit charge is

associated with each drum. Drum deposit costs are refunded quarterly and therefore have a minimal effect on the cost savings related to the use of a solvent reclamation unit. Return transportation costs related to ethanol drums are not, however, recoverable and are therefore represented in the total cost savings related to a Solvent Reclamation System. Empty drums are currently returned via Kingsway Transit. Empty drum returns are regulated under the Transportation of Dangerous Goods Act.

TRANSPORTATION COSTS FOR RETURNING EMPTY ETHANOL DRUMS

TOTAL RETURN TRANSPORTATION COSTS FOR 1990:	$967.68
TOTAL RETURN TRANSPORTATION COSTS FOR 1991:	$1,088.64
TOTAL RETURN TRANSPORTATION COSTS FOR 1992:	$814.25
TOTAL RETURN TRANSPORTATION COSTS FOR 1993:	$836.70
TOTAL RETURN TRANSPORTATION COSTS FOR 1990-1993:	$3,649.70

ANNUAL COST AND USAGE FIGURES FOR ANHYDROUS ETHANOL

TOTAL USAGE (VOLUME IN LITRES) FOR 1990:	5,040.00
TOTAL COSTS FOR 1990: $5,004.72	
TOTAL USAGE (VOLUME IN LITRES) FOR 1991:	5,040.00
TOTAL COSTS FOR 1991: $5,256.72	
TOTAL USAGE (VOLUME IN LITRES) FOR 1992:	5,670.00
TOTAL COSTS FOR 1992: $6,083.91	
TOTAL USAGE (VOLUME IN LITRES) FOR 1993:	5,670.00
TOTAL COSTS FOR 1993: $6,350.40	
TOTAL USAGE (VOLUME IN LITRES) FOR 1990-1993:	21,420.00
TOTAL COST FOR 1990-1993: $22,695.75	

The average daily rate of consumption (based on 249 working days a year) of anhydrous ethanol, over the four years reviewed, was 21.5 litres. The Labmaster solvent reclamation system must be able to safely recycle the waste ethanol at a reasonable rate and to a high degree of purity in order for the concept to be both practical and economically feasible. With virgin ethanol costing $22,695.75 over the last four years, the use of a solvent reclamation system capable of efficiently and economically recycling virgin grade ethanol would, on ethanol recycling alone, reduce

this Laboratory's annual operating costs by approximately $4,000.00.*

The system is equipped with 75 litre capacity storage containers. With the system operating at a solvent recovery rate of 11 litres per hour, it would only be necessary to run the system 8-10 times (for a 5 hour period each run) each month, in order to recycle enough ethanol to accommodate our needs. The Labmaster Solvent Recovery System will recover ethanol of virgin quality and of 95% purity; coupled with a Molecular Sieve (Mermaid System) for the removal of approximately 4% water remaining in the reclaimed ethanol, this system will provide us with a grade of ethanol sufficient for use as anhydrous ethanol for the routine processing of tissue and staining of slides.

* This estimate is based on the expectation that the Zeolite Sieve (Mermaid) technology operates as reported. There will be some operational costs involved with running the sieve (ie. purchase of sieve material at an estimated $6.00/ lb. with 50 lb. lasting approximately 6 months). It is also estimated that approximately 1/3 of the present volume of anhydrous ethanol will still be required to supplement the Recovered Ethanol. If the reclamation system is only capable of efficiently and economically recycling 95% ethanol rather than anhydrous ethanol, it is estimated that the annual cost savings would be $2,653.10 or a 40% reduction in the use of Virgin Anhydrous Ethanol.

ANNUAL COST AND USAGE FIGURES FOR XYLENE

Xylene is the principle clearing agent used in the processing of tissue in the Anatomic Pathology laboratory. It is also used as a clearing agent for slide preparation and in staining procedures. Xylene is purchased in 210 L drums as required. There is no associated drum deposit cost and the empty drums are utilized for holding and shipping the waste xylene produced as a result of our tissue processing.

TOTAL USAGE (VOLUME IN LITRES) FOR 1990:	1,890
TOTAL COSTS FOR 1990: $1,492.20	
TOTAL USAGE (VOLUME IN LITRES) FOR 1991:	2,100
TOTAL COSTS FOR 1991: $1,811.90	
TOTAL USAGE (VOLUME IN LITRES) FOR 1992:	1,890
TOTAL COSTS FOR 1992: $1,630.71	
TOTAL USAGE (VOLUME IN LITRES) FOR 1993:	1,680
TOTAL COSTS FOR 1992: $1,536.48	
TOTAL USAGE (VOLUME IN LITRES) FOR 1990-1993:	7,560
TOTAL COST FOR 1990-1993: $6,471.29	

The average daily rate of consumption of xylene over the past four years was 7.6 litres. The Labmaster solvent reclamation system must be able to safely recycle the waste xylene at a reasonable rate and to a high degree of purity in order for the concept to be both practical and economically feasible. With virgin xylene costing $6,471.29 over the period studied, the use of a solvent reclamation system capable of efficiently and economically recycling virgin grade xylene would, on xylene recycling alone, reduce this Laboratory's average annual operating costs by at least $1,600.00. The reduction in volume of waste xylene is estimated to be 1,739 L, or 92%.

There are no empty drum costs associated with Xylene as the empty drums are used to store and ship the waste Xylene resulting from the daily processing of tissue samples in the Pathology lab.

The Labmaster system is equipped with 75 litre capacity storage containers. With the system operating at a solvent recovery rate of "55 litres every 3 hours" it would only be necessary to run the system 3-4 times each month in order to recycle enough xylene to accommodate our needs. The Labmaster Solvent Recovery System will recover xylene of 100% virgin purity therefore the reclaimed xylene will be sufficient for use in the routine processing of tissue.

ANNUAL COST AND USAGE FIGURES FOR METHANOL

Methanol is the principle agent used by the Haematology Laboratory for the production of stained blood films.

TOTAL USAGE (VOLUME IN LITRES) FOR 1990: TOTAL COSTS FOR 1990: $1,091.65	1,470
TOTAL USAGE (VOLUME IN LITRES) FOR 1991: TOTAL COSTS FOR 1991: $1,091.65	1,470
TOTAL USAGE (VOLUME IN LITRES) FOR 1992: TOTAL COSTS FOR 1992: $1,375.29	1,470
TOTAL USAGE (VOLUME IN LITRES) FOR 1992: TOTAL COSTS FOR 1992: $1,615.68	1,680
TOTAL USAGE (VOLUME IN LITRES) FOR 1990-1993: TOTAL COSTS FOR 1990-1993: $5,174.27	6,090

The average daily rate of consumption of absolute methanol over the past four years was 6 litres. The Labmaster solvent reclamation system must be able to safely recycle the waste methanol at a reasonable rate and to a high degree of purity in order for the concept to be both practical and economically feasible. With virgin methanol costing

$5,174.27 over the past four years, the use of a solvent reclamation system capable of efficiently and economically recycling virgin grade methanol would, on methanol recycling alone, reduce this Laboratory's annual operating costs by at least $1,164.20 or 90% of our average annual methanol costs. This would realize a reduction of waste methanol of 1,323.0 L.

The system is equipped with 75 litre capacity storage containers. With the system operating at a virgin solvent recovery rate of "55 litres every 5 hours" it would only be necessary to run the system 2-3 times each month in order to recycle enough methanol to accommodate our needs. The Labmaster Solvent Recovery System will recover methanol of virgin quality of 100% purity therefore the reclaimed methanol will be sufficient for use in the preparation and differentiation of the routine Romanowsky type stain used in the Haematology Lab.

DISPOSAL COSTS FOR XYLENE and METHANOL

The Henderson General Laboratory has utilized the services of several companies over the past four years in order to try and obtain the most cost effective means of safely disposing of our waste xylene and methanol. We have used TRICIL, LAIDLAW, PROVINCIAL and The New Horizons Company for disposing of our waste solvents. Each of the companies have had the proper registration with the Provincial Government and have provided us with the proper documentation for each of the shipments they have removed from our premises. We currently utilize the services of The New Horizons Company who inform us that our wastes are either being recycled and sold as "Recycled Solvents" or are being used as alternate fuels by companies which have the proper SCRUBBERS in place in their stacks to accommodate such fuels. The costs associated with removing the waste from our premises and having companies dispose of our wastes are not recoverable. Our only options in reducing these costs are either to reduce the quantities of waste to be removed or to recycle our own waste on site.

TOTAL COSTS FOR 1990: $3,600.00

TOTAL COSTS FOR 1991: $4,190.00

TOTAL COSTS FOR 1992: $2,935.00

TOTAL COSTS FOR 1993: $2,813.00

TOTAL DISPOSAL COSTS FOR XYLENE AND METHANOL FOR 1990-1993: $13,538.00

It is estimated that there will be one drum of each waste material (xylene and methanol) to be disposed of every 18 months, as there is approximately 2 litres of residual waste solvent remaining after each cycle. This is an inherent feature of the Labmaster unit. Increased cycle time does not decrease the residual waste solvent.

SUMMARY

Cost of Virgin Solvents for 1990-1993: $37,654.50

Cost of Drum Transportation 1990-1993: $ 3,707.31

Cost of Waste Disposal for 1990-1993: $13,538.00

Total Cost of Solvents 1990-1993: $54,899.81

Estimated annual savings possible with the use of a Solvent Recovery System: $8,600.00

Broken down as follows:

1. Decreased Empty Drum Transport. Costs:	$ 380.00
2. Decreased volume of Anhydrous Ethanol:	$2,650.00**
3. Reduction of Xylene Costs:	$1,370.00
4. Reduction of Methanol Costs:	$1,160.00
5. Virtual Elimination of Waste Disposal:	$3,040.00
	=========
	$8,600.00

**This value may go as high as $4,000.00 depending on the Sieve Technology

PURCHASE AND IMPLEMENTATION OF THE SYSTEM

The Labmaster Unit was ordered 28/03/94 and the Purchase Order was confirmed and verified on 30/03/94. The first components of the Labmaster Unit were delivered on 13/04/94. The first shipment consisted of the Recycling unit and the electronic transfer pump as well as the Closed Loop Cooling System (CLCS) container. The shipment of the submersible circulating pump, for the CLCS, was delayed for four (4) weeks.

Electrical renovations to the Explosion Proof Class I environment, in which the Labmaster Unit was to be housed, were undertaken by a local outside contractor (Harbour Electric Limited). Once all the electrical components of the system had been received the renovations were completed on 27/05/94.

Plumbing renovations were undertaken by the Hospital Maintenance Department at the expense of the Hospital. The plumbing renovations were completed on 10/06/94. It was considered too costly to plump a constant supply of cold water, as well as a drain for coolant run-off, to the Flammable Storage Room. The use of the Closed-Loop Cooling System was considered to be the least expensive alternative to costly plumbing

renovations. The cooling system incorporates the use of a 300 gallon storage tank and submersible circulating pump to supply the Solvent Recovery System with a steady supply of coolant.

The Labmaster Unit was Set-up and operational instructions were given by the CMT representative to the Chief Technologist and the Lab Porter on 14/06/94 as documented in the Service Report.

A comprehensive and concise "Operations Manual" was prepared by the Chief Technologist, to cover the operational requirements of the Labmaster Unit. The manual was reviewed by the Lab Porter (the principle operator of the Unit) to ensure an understanding of instructions and to appraise the completion of the manual.

The Hospital Occupational Health and Safety Officer was invited to inspect the Labmaster Unit and its environment and to comment on any obvious or potential violations of Safety Protocol. The Flammable Storage Room and Labmaster Unit passed inspection after some modifications were undertaken. The modifications included the use of an approved face mask to protect the operator from short periods of potential high exposure to fumes as well as the review of tools used in the Flammable Storage Room to ensure that all were constructed of a "non-sparking" material.

Operation of the Labmaster Unit began on 21/06/94 with the reclamation of Waste Xylene. The original proposal stated that Phase I would involve the reclamation of Xylene, Methanol and 95% Ethanol and would occur between May and November of 1994. Our actual start date was delayed 51 days due to back orders of Labmaster components, renovations and planning. From the time the operation of the system began this Laboratory has, with a few exceptions, successfully recovered all Xylene waste since 21/06/94 and all 95% Ethanol waste since 01/08/94. The recovery of our Methanol waste originally met with limited success. Two (2) out of four (4) Methanol waste recovery runs between 16/08/94 and 20/12/94 yielded recovered solvent of a high enough purity to be re-used. The methanol which was not reusable, due to contamination with xylene, was disposed of via the New Horizons company.

On September 9, 1994 a letter confirming the approval of the application for grant monies was received. Signed copies of the agreement were returned to the Ministry of Environment and Energy for counter-signature by the Assistant Deputy Minister. We have received, on October 31, 1994, a copy of the agreement which was dated October 19, 1994. The copy of the signed agreement has been filed in our Laboratory Administration Office.

Phase II of the planned Implementation of the Labmaster System began on November 7, 1994. The Molecular Sieve was received on 17/09/94 and installed, after electrical renovations by Harbour Electric Limited, on 28/09/94. A copy of the additional costs ($379.46) were submitted to the Ministry for possible inclusion to the list of costs eligible for funding assistance within the definition of the grant. These costs were subsequently

found to be ineligible as they were not included in the original submission.

Phase II involved the plan to recover our absolute ethanol waste and remove any traces of water in order that it may again be used as absolute ethanol for tissue processing. It was hoped that, if successful, the Laboratory could reduce the quantities of virgin ethanol used by approximately 25% over that which had already been achieved.

The availability of waste ethanol was restricted to the operational output of our Laboratory which, although slight fluctuations occurred, was stable at the quantities listed in APPENDIX A. There was no intention for this system to be marketed as a possible centre for solvent waste reclamation. It was to be used exclusively for the expressed purpose of recycling organic solvent wastes produced by the Henderson General Laboratory.

DESIGN OF THE RECOVERY PROCESS - FLOOR PLAN

The original design of the Flammable Storage area included a "diked" floor, to contain any potential spills of solvents, a "blow-off" roof, to muffle the impact of any potential explosive mishap, ventilation, to control any potential hazardous fumes, explosion proof electrical design, to prevent potential sparks, a grounding system, to ensure all metal containers are grounded and non-sparking, and cages to segregate various solvents.

Incorporating this original design, the contents of the room were reorganized to allow for the accommodation of the Labmaster Solvent Recovery Unit, the Electric Transfer Pump, the Closed Loop Cooling System and the "Mermaid" Molecular Sieve in a cage separate from the rest of the stored solvents. A Floor Plan is attached as APPENDIX B. From reviewing page 1 of the Floor Plan it is possible to ascertain the flow of the Solvent Recovery Process.

Waste Solvents, which are intended for recovery, are collected into the 210 L drums #1-4, located in Cage #1. Waste xylene, which is to be discarded and which builds up at a rate of one American gallon per waste xylene recovery run, is also located in Cage #1 along with the Recovered Xylene and stocks of Virgin Methanol. All drums are labelled in an obvious manner. A copper tube system was installed to connect Cage #1 to the Electric Transfer Pump located in Cage #2. A copper dip tube is attached to the end of the copper pipe, located in Cage #1, by means of solvent resistant polyethylene tubing (purchased from Charles Jones IND Inc of Stoney Creek). The tubing was chosen for its resistance to methanol, ethanol and xylene. The length of the plastic tubing is such that the dip tube can be securely placed into any of the 210 litre drums used to store the waste solvents which are to be recovered. The electric transfer pump provides the operator with the means to safely and efficiently transfer waste solvents from the storage area into the Labmaster Solvent Recovery Unit. Valves at either end of the transfer system provide the means to control the flow of solvent being transferred. The copper tubing was installed such that the end in Cage #1 is lower than the end

attached to the Electric Transfer Pump in Cage #2 providing a natural gravity drainage effect for any solvent left in the pump or copper tubing leading to the pump once the transfer of solvents is completed. A valved access between the pump and the dip tube end of the copper tubing was also installed. This provides the operator with the ability to flush the pump with clean solvent to prevent the build up of waste products on the impellers of the pump itself.

Waste solvents are recovered as the need arises however, once the recovery of a particular waste solvent is initiated, the entire contents of the waste drum are recycled in successive runs. This aspect of the recovery process is a result of hands-on experience with the system. Ease of use by the operator, increased purity of yield and the reduction of "head cleaning" between different types of solvents being recovered are the three major factors for this particular aspect in the design of the process used at the Henderson General Hospital.

Once the waste solvent has been transferred to the Labmaster Unit the unit is secured by clamping the lid onto a solvent resistant O-ring. The appropriately labelled plastic collection container is attached to the Labmaster Unit by means of a lock-fit valve system. The Labmaster Unit is permanently attached to the Closed Loop Cooling system and once the lid is clamped the cooling system is activated. The appropriately operating temperature is selected on the dialled unit attached to the Labmaster Unit. The power to the unit is engaged by means of a switch located adjacent to the Closed Loop Cooling System. The power cannot be engaged if the Cooling System has not been activated (one of the safety designs inherent in the Labmaster System). Page 3 of Appendix B diagrammatically depicts the essential components discussed here.

The recovery process is complete within 6 to 8 hours. The Labmaster Unit operates without the need for operator intervention during the entire recovery cycle. The recovered solvent is contained within the appropriately labelled blue plastic storage containers provided with the Recovery System. The containers are designed with a carbon snorkel and are fitted with a sturdy castor system to allow for easy movement. The recovered solvent is wheeled out Cage #2 to the Cage which houses the appropriately labelled 210 L drum and transferred into the Recovered Solvent Storage drum. This allows for the blue plastic storage unit to be used for the next cycle of waste recovery.

PURITY ANALYSIS

Samples of each of the recovered solvents were analyses throughout the course of the project in order to compare to the Gas Chromatography Interpretations in CMT published Sales Literature.

According to the literature the operator should, if operating the system within defined specifications, expect purity and water content in the following ranges:

Reclaimed Xylene: G.C. Plot shows 99.37% of total organics is Xylene

Karl Fisher Water Analysis = 0.061% of sample

Reclaimed Ethanol: G.C. Plot shows 98.63% of total organics is Ethanol

Karl Fisher Water Analysis = 5% of sample

Reclaimed Methanol: Expected Results as per Ethanol

N.B. different Azeotropes exist which should result in less than 3% water content in the reclaimed product

The expectation of purity of recovered solvents was important in the selection of the system. Guarantees from CMT with regards to the above mentioned purity analyses were part of the purchasing agreement.

Xylene:

The purity of the xylene is the first to be reviewed in this section of the report. Modifications to the reclamation process for waste xylene were implemented as the result of a perceived lack of purity of the reclaimed xylene; it took several months for the lack of purity to manifest itself and several months to resolve the problem.

The first set of analysis received was performed on samples sent directly to CMT. A Gas Chromatography Analysis, performed on a SRI 8610 Unit, revealed that the purity of the reclaimed Xylene was 98.781% with 0.0002 Water Content. CMT considered this result to be "exceptional". The analysis revealed that the reclaimed Xylene was within 0.589% of the figures published by CMT. Concerns regarding the lack of an exact match with the published figures as well as an inability to decipher the exact chemical composition of the remaining 1.219% of the reclaimed xylene led us to attempt our own analysis on a Gas Chromatography resident in the Chemistry Department of our institution. Our chemists attempted the analysis but were unsuccessful due to the high temperatures required to be maintained for this particular type of investigation.

More samples were sent to CMT but due to their slow response we attempted to locate a local chemical company to handle any further investigations on the reclaimed solvents. While our search for a company ran its course we began to experience peculiarities, first in the processing of our tissue samples, then in the staining of the final sectioned tissue. The tissue blocks were beginning to sink in the centre and xylene baths, used to stain the H & E slides, were showing definite signs of "ethanol" contamination (ie. poor draining and beading of solvent on the face of the slides). As well, the pen which was used to permanently mark the tissue cassettes processed through the various solvent

baths, including reclaimed ethanol and xylene, was no longer indelible. When the supplier was contacted the conversation revealed that although the pens were indelible when passing from pure ethanol to pure xylene the marks produced by the pens could be removed if the cassettes were submersed in a bath containing a mixture of both solvents.

Working closely with ESBE Inc. a new chemical analysis of the reclaimed xylene solvent was finally obtained on 04/04/95. The company utilized for the analysis was the Hunter Group, located in Aurora, Ontario. The company produces high quality solvents which it sells for distribution by such Laboratory Supply companies as Fisher Scientific. This analysis revealed that the purity of the recovered xylene had dropped to 95.71% since the last analysis. The G.C. peaks accounting for the remaining 4.28% of reclaimed xylene were not identified. The xylene analyses had been in use since July, 1994. The xylene had been processed through at least 12 separate recovery runs. Unfortunately, the request for analysis had not included identification of peaks other than xylene.

It was decided, after negotiations with ESBE, that the xylene currently in use would be disposed of and that a drum of virgin xylene would be purchased. The cost of disposal and purchase of the virgin xylene was absorbed by ESBE. The procedure for reclaiming the xylene was reviewed and it was determined that xylene would be reclaimed only after all the virgin stock had been used and that the entire volume of waste xylene would be recovered in successive runs prior to being re-used for processing. It was agreed that samples from each of the "sets" of reclaimed xylene would be collected and analyses specifically for ethanol content. In this way it was hoped to determine if the unidentified peaks were ethanol and to correlate the build up of ethanol, within a controlled time frame; with the anomalies of processing and staining which had been noticed with the first attempt at xylene recovery.

Results from the above mentioned process, obtained on August 11, 1995, revealed that ethanol was slowly accumulating in the reclaimed xylene. After four successive reclamation runs the ethanol content in the reclaimed xylene rose from 0.5575% to 1.2685%. The accumulation of ethanol was consistent with the adverse effects suspected to be associated with the presence of ethanol in the reclaimed xylene.

After the review of the above mentioned results ESBE again agreed to remove the xylene in circulation and to replace it with Virgin Xylene at their expense. ESBE also suggested a solution to the accumulation problem which was immediately adopted for any future xylene reclamation runs. The solution entailed adding one litre of saturated sodium chloride to each run of waste xylene reclaimed. The intention was for any ethanol to be bound to the aqueous form of the salt which would be evaporated off as the initial distillate and discarded.

The addition of saturated sodium chloride to the waste xylene resulted in a net amount of ethanol in the first reclamation run of 0.0055% with no other peaks identified except for xylene. The results of this analysis were received on October 30, 1995 (see

Appendix C). When comparing the results of the reclaimed xylene to that of virgin xylene it is noted that the purity of the reclaimed product is within 0.04% of the virgin xylene. It is also noted that the waste xylene, prior to reclamation, contained 5.9288% ethanol but after reclamation with the new protocol the ethanol content was less than 0.01%.

No processing anomalies have been noted since the implementation of the change to the reclamation cycle for xylene. The xylene currently in circulation, as of the date of this report, has been processed through three reclamation cycles with no indication of ethanol accumulation. It would appear that the xylene will be able to be recycled indefinitely with no loss of purity. Further analysis of the reclaimed xylene will be undertaken periodically to ensure the purity of the product.

Ethanol:

The water content of the reclaimed ethanol produced by the Labmaster system has been assessed primarily by means of an in-house method which relies upon matching the readings of hydrometers (purchased from Fisher Scientific) to percent purity figures listed in the Canadian Alcoholometric Tables. The tables were published by Revenue Canada Customs and Excise. By this method waste ethanol was found to have accumulated as much as 21% water content prior to reclamation.

According to the literature which accompanied the Labmaster system, "Alcohol molecularly bonds to water making it impossible for the reclaimed distilled alcohol to have a water content percentage below its pre-distillation water percentage or its azeotrope percentage, whichever is lower. Ethanol has an azeotrope of 8%. If the pre-distilled ethanol has a water content of 8% or greater the reclaimed ethanol will have 8% water content. However, if the pre-distilled ethanol water content is less than 8% the distilled ethanol water content will be equal to the pre-distilled content percentage. Therefore, if the intent is that the reclaimed ethanol will have a water content of 5% or less the pre-distilled ethanol will have to have a water content of 5% or less".

The proposal sent the Ministry outlined the intentions of this Lab to recover and re-use 95% ethanol in Phase I of the project. Phase II of the project included a proposal to attempt to reclaim and reuse absolute ethanol by utilizing a new product produced by CMT designated "Mermaid". This product is a molecular sieve which is intended to absorb the azeotrope form of the ethanol onto the surface of 3 or 4 micron beads of sieve material as the solvent is repeatedly pumped through a column containing the sieve material.

A means of segregating the waste ethanol prior to attempting to reclaim the solvent on the Labmaster Solvent recovery system was put in place. Only waste ethanol which had not been contaminated with xylene could be reclaimed as the system is not able to separate xylene from ethanol. Ethanol, as mentioned earlier, is the primary dehydrating

agent used in the tissue processing cycle. It is also required as a hydrating and dehydrating agent in the staining of routine histology and cytology slides. Absolute ethanol is diluted with water to prepare three baths of "95%" ethanol on each of two tissue processors. Three baths of absolute ethanol follow the "95%" baths on each of the tissue processors.

It was determined that all graded alcohols from the tissue processors and all alcohols from the dehydration portion of all staining systems in histology and cytology would be selected for recovery in Phase I. This ethanol was designated as "95% ethanol waste" and segregated as such. It was also determined that "absolute ethanol waste" resulting from the routine processing of tissue samples, (ie. only those portions of the tissue processing cycle which utilize absolute ethanol), would be segregated and collected for potential recovery in Phase II. It was estimated that yield from the collection of the two designated waste ethanols would result in at least one third of all ethanol utilized in the Pathology Lab being recycled.

Purity of a sample of the reclaimed 95% ethanol was assessed by the Hunter Group, on October 30, 1995, to be 99.3907% pure ethanol and 0.1426% pure methanol. All 95% grade ethanol used on the tissue processors is of "reclaimed ethanol" only. Virgin stock is no longer diluted with water to prepare 95% ethanol for use on the tissue processors. No adverse effects have been noted over the sixteen months that the reclaimed 95% ethanol has been used on the tissue processors.

The Phase II aspect of the project has had a few barriers which have yet to be overcome. While the purity of the ethanol is 99.3907% and while the molecular sieve has been successful in removing almost all the water from the reclaimed "absolute ethanol" (hydrometer readings match 99.89% pure ethanol) we experience processing anomalies when the reclaimed "absolute ethanol" is used without at least one virgin ethanol in the final dehydrating position. Also, the molecular sieve material seems to shed a fine residue after it is "dried out" for reuse, using the Labmaster Unit as a drying oven. Investigations are still proceeding in this area as it is believed that persistence will yield a satisfactory product, resulting in more cost savings and less waste for disposal.

Methanol:

Methanol reclamation has followed closely with the results noted in Phase I of the ethanol reclamation with the single exception that the reclaimed methanol is very sensitive to changes in humidity. Water is very readily absorbed into methanol in a humid environment. It seems the reclaimed methanol is especially susceptible to humid conditions. In fact the Haematology Lab, which utilizes methanol as the primary solvent in the production of Romanowsky stained blood films, experiences periods of poor staining even with top grade virgin methanol, during periods of high humidity. Early on in the reclamation process it was noted that the reclaimed methanol was causing

crenation in the red blood cells. Analysis of the reclaimed methanol in March of 1995 revealed the presence of xylene. As a result of this finding all methanol which had been reclaimed to that date was discarded and the process was modified to ensure that the cooling head of the Labmaster unit was rinsed even more thoroughly than it was previously and that xylene runs would not be performed immediately prior to the reclamation of methanol. In fact the procedure is now to reclaim methanol only after an ethanol run. Reclaimed methanol became available in mid June of 1995 and has been used successfully since. It is estimated that the amount of virgin methanol ordered will drop to the levels previously predicted.

COMPARISON OF PROJECTED AND ACTUAL REDUCTIONS ACHIEVED

Evaluation of Appendix A, displaying the Solvent usages and waste solvent production, prior and post implementation of the Labmaster Solvent Recovery system, reveal that the actual cost savings, of both reduction in costs of virgin solvents and reduction in costs of waste disposal, have been note worthy. A solvent by solvent analysis of the cost savings as well as the reduction in wastes released to the environment follows.

Ethanol:

The table in Appendix A reveals that the volume of Ethanol purchased from January 1990 to December of 1993 totalled 21,420 litres at a cost of $22,695.60. The average annual volume of ethanol purchased during this period was 5,355 litres at an average annual cost of $5,674.00. During this period the volume of waste ethanol disposed of equalled the volume of virgin ethanol purchased. Therefore, on average, 5,355 litres of ethanol was disposed of each year for the four years 1990 through 1993. Comparing the first year of operation of the Labmaster System (considering that the system was not operational until 21/06/94) to the average annual volume of ethanol purchased during the four years prior to implementing the Labmaster System, it is noted that a 17.6% volume decrease occurred for the 6 month period of operation in 1994. This volume decrease represents a 10.6% decrease in the purchase costs for virgin ethanol and a 18.6% decrease in the amount of waste ethanol released into the Hamilton-Wentworth sewage system. Utilizing the same annual average figures (pre-implementation) to the projected 1995 figures it is noted that the amount of virgin ethanol purchased will be reduced by 33.3% (down to 3,370 litres from 5,355 litres) which represents a 23.2% reduction in costs ($4,355.40 down from $5,674.00). Reclaiming all of the waste ethanol produced from the processing of tissue samples and recycling the reclaimed waste into the tissue processing routine will produce a 26.2% reduction in waste ethanol released into the Hamilton-Wentworth sewage system. Even though current Hamilton-Wentworth sewage bylaws provide for the disposal of ethanol into the sewage system it was considered an additional benefit of the operation of this system to reduce the amount of ethanol waste disposed in the

event that the bylaws change.

The cost of transporting empty ethanol drums to the supplier will decrease in 1995, over the average annual cost of transportation of empty drums for the four years preceding the use of the Solvent Recovery system, by 17.5% or $161.82.

It was estimated that the annual cost savings in the purchase of anhydrous ethanol would be $2,650.00 and the cost of transporting empty ethanol drums would decrease by $380.00. In actuality the cost savings for virgin ethanol, after the implementation of the Labmaster System, are $1,318.60 when compared to the four year annual average cost of virgin ethanol or $1,995.00 when comparing the first full year of operation of the system (1995) to the last full year (1993) prior to the implementation of the system.

The estimated cost savings for ethanol was high by approximately $873.00 per year.

Xylene:

The table reveals that the volume of Xylene purchased from January 1990 to December of 1993 totalled 7,560 litres at a cost of $6,471.29. The average annual volume of xylene purchased during this period was 1,890 litres at an average annual cost of $1,617.82. During this period the volume of waste xylene disposed of equalled the volume of virgin xylene purchased. Therefore, on average, 1,890 litres of xylene was disposed of each year for the four years 1990 through 1993. The cost of disposing the waste xylene, for the four year period, described was $7,171.00. The average annual cost of disposing of the waste xylene was $1,793.50.

Comparing the first year of operation of the Labmaster System (considering that the system was not operational until 21/06/94) to the average annual volume of xylene purchased during the four years prior to implementing the Labmaster System, it is noted that a 44.4% volume decrease occurred. This volume decrease represents a 50.5% decrease in the purchase costs for virgin xylene. Utilizing the same period comparison the amount of waste xylene disposed of decreased by 55.5% (down to 840 from 1890 litres). The comparative cost of disposing of xylene waste decreased by 61% (down to $700.00 from $1,793.50) during the first year of operation.

Utilizing the same annual average figures (pre-implementation) to the projected 1995 figures it is noted that the amount of virgin xylene purchased will be reduced by 89% (down to 210 litres from 1,890 litres) which represents a 86.5% reduction in costs ($218.15 down from $1,617.82). Reclaiming all of the waste xylene produced, from the routine processing of tissue samples and routine staining procedures, and recycling the reclaimed waste back into the same routines will produce an 89% reduction in waste xylene disposed of by the Henderson General Laboratory for 1995.

It was estimated that the annual cost savings in the purchase of virgin xylene would be $1,370.00. In actuality, the cost savings for virgin xylene, after the implementation of

the Labmaster System, are $1,399.67 when comparing to the four year annual average cost of virgin xylene. It was estimated that virtually all of the waste xylene and methanol costs would be eliminated after the implementation of the Labmaster System and that all waste xylene would be reclaimed and recycled, reducing the disposal of waste xylene to 210 litres per year. The average annual cost of disposing of xylene waste prior to the Labmaster System was $1,793.50. The estimated cost of disposing of waste xylene by the end of 1995 is $175.00. This represents an average annual cost savings of $1,618.50 and reduces the amount of waste xylene disposed of to 210 litres per year.

The expected cost savings, with regards to xylene, by the end of 1995 compared to the annual average xylene costs for the four years prior to the implementation of the Labmaster System are $3,018.17.

N.B. The costs born by ESBE, associated with the purchase of virgin xylene and waste disposal of the ethanol contaminated xylene are not listed on the second page of Appendix A but the volumes related to actual use are included (see * preceding Xylene on page 2 of Appendix A).

Methanol:

Appendix A reveals that the volume of Methanol purchased from January 1990 to December of 1993 totalled 6,090 litres at a cost of $5,174.27. The average annual volume of methanol purchased during this period was 1,523 litres at an average annual cost of $1,293.57. During this period the volume of waste methanol disposed of equalled the volume of virgin methanol purchased. Therefore, on average, 1,523 litres of methanol was disposed of each year for the four years 1990 through 1993. The cost of disposing the waste methanol, for the four year period, described was $6,364.00. The average annual cost of disposing of the waste methanol was $1,591.00.

Comparing the first year of operation of the Labmaster System (considering that the system was not operational until 21/06/94) to the average annual volume of methanol purchased during the four years prior to implementing the Labmaster System, it is noted that a 3.6% volume decrease occurred. This volume decrease, coupled with a drastic but temporary drop in the price of virgin methanol, represents a 32% decrease in the purchase costs for virgin methanol. Utilizing the same period comparison the amount of waste methanol disposed of decreased by 31% (down to 1050 from 1523 litres). The comparative cost of disposing of methanol waste decreased by 34% (down to $1,050.00 from $1,591.00) during the first year of operation.

Utilizing the same annual average figures (pre-implementation) to the projected 1995 figures it is noted that the amount of virgin methanol purchased will be reduced by 17.3% (down to 1260 litres from 1,523 litres) which represents a 0% reduction in costs (holding at $1,299.72 due to the dramatic price increase of virgin methanol from 1994 to 1995). Reclaiming 58.5% of the waste methanol produced, from the routine staining of blood films, and recycling the reclaimed waste back into the same routine will produce a

58.5% reduction in waste methanol disposed of by the Henderson General Laboratory for 1995.

It is estimated that the annual cost savings in the purchase of virgin methanol will be nil for 1995 but will be very substantial in 1996. It was estimated that virtually all of the waste methanol costs would be eliminated after the implementation of the Labmaster System and that all waste methanol would be reclaimed and recycled, reducing the disposal of waste methanol to 210 litres per year. The average annual cost of disposing of methanol waste prior to the Labmaster System was $1,591.00. The estimated cost of disposing of waste methanol by the end of 1995 is $525.00. This would represent an average annual cost savings of $1,066.00 and would reduce the amount of waste methanol disposed of to 630 litres for 1995.

The expected cost savings, with regards to methanol including the purchase of virgin solvent and the costs of disposing, by the end of 1995 compared to the annual average methanol costs for the four years prior to the implementation of the Labmaster System are $1,717.00.

FINAL ANALYSIS - CONCLUSIONS

While some aspects of the reclamation system took longer to implement and while revisions had to be undertaken to ensure that the purity of the product was sufficient to meet the needs of the various areas in the Laboratory it is obvious that the implementation of solvent reclamation at the Henderson General Hospital has been a very successful venture.

The estimates, made prior to implementation of the Labmaster system, while appearing a bit high at this time, may well be obtainable once cost savings are realized in the areas of virgin methanol purchases and decreased costs associated with decreased waste methanol disposal.

Evaluation of the cost savings for the first full year of operation (1995) reveals a reductions of $5,400.00 in the operating costs of the Henderson General Department of Laboratory Medicine. At this rate of savings the entire project will be payed back in under 4 years. The most substantial savings come in the form of reduced virgin xylene costs and reduced costs for disposing of waste xylene (combining for a total of $3,018.00), the second area of savings comes in the form of reduced purchases of virgin ethanol and the reduced cost of transporting empty ethanol drums (combining for a total of $1,320.00) and finally a reduction in the costs of purchasing virgin methanol along with reduced costs for disposing of waste methanol (combining for a total of $1,060.00). The amount of xylene waste disposed of in 1995 was reduced to 630 litres, down from an annual average of 1,890 litres. This amount will reach 210 litres in 1996 since the ethanol contamination problem has been satisfactorily dealt with (this inflated the xylene waste figure for 1995 by 420 litres). The amount of ethanol waste disposed

of in 1995 was reduced to 2,634 litres, down from an annual average of 5355 litres. A total of 936 litres of waste ethanol was recycled to be reused for the routine processing of tissue specimens in Pathology. The amount of waste methanol disposed of in 1995 was reduced to 630 litres, down from an annual average of 1,523 litres. Modifications to the operation of the Labmaster System (to provide for methanol recycling runs to occur only after ethanol and not xylene runs) should improve the yield of usable reclaimed methanol.

APPENDIX A
SOLVENT USAGE AND WASTE PRODUCTION ANALYSIS
DEPARTMENT OF LABORATORY MEDICINE, HENDERSON GENERAL HOSPITAL

CALANDAR YEAR	SOLVENT	ANNUAL USAGE (litres)	ANNUAL COSTS	WASTE QUANTITIES (litres)	DISPOSAL & HANDLING COSTS	TOTAL COSTS
1990	ETHANOL @$208.53/Drum	5040	$5,004.72	5040	$0.00	$5,004.72
1990	XYLENE @$165.80/Drum	1890	$1,492.20	1890	$1,935.00	$3,427.20
1990	METHANOL @$155.95/Drum	1470	$1,091.65	1470	$1,665.00	$2,756.65
1990	EMPTY DRUM TRANSPORT			24 Drums	$967.68	$967.68
1990 TOTALS		8400	$7,588.57	8400	$4,567.68	$12,156.25
1991	ETHANOL @$219.03/Drum	5040	$5,256.72	5040	$0.00	$5,256.72
1991	XYLENE @$181.19/Drum	2100	$1,811.90	2100	$2,365.00	$4,176.90
1991	METHANOL @$155.95/Drum	1470	$1,091.65	1470	$1,825.00	$2,916.65
1991	EMPTY DRUM TRANSPORT			24 Drums	$1,088.64	$1,088.64
1991 TOTALS		8610	$8,160.27	8610	$5,278.64	$13,438.91
1992	ETHANOL @$225.33/Drum	5670	$6,083.91	5670	$0.00	$6,083.91
1992	XYLENE @$181.19/Drum	1890	$1,630.71	1890	$1,467.50	$3,098.21
1992	METHANOL @$196.47/Drum	1470	$1,375.29	1470	$1,467.50	$2,842.79
1992	EMPTY DRUM TRANSPORT			27 Drums	$814.25	$814.25
1992 TOTALS		9030	$9,089.91	9030	$3,749.25	$12,839.16
1993	ETHANOL @$235.20/Drum	5670	$6,350.40	5670	$0.00	$6,350.40
1993	XYLENE @$192.06/Drum	1680	$1,536.48	1680	$1,406.50	$2,942.98
1993	METHANOL @$201.96/Drum	1680	$1,615.68	1680	$1,406.50	$3,022.18
1993	EMPTY DRUM TRANSPORT			27 Drums	$836.70	$836.70
1993 TOTALS		9030	$9,502.56	9030	$3,649.70	$13,152.26
1990 through 1993 FOUR YEAR TOTALS		35070	$34,341.3	35070	$17,245.27	$51,586.58
FOUR YEAR AVERAGE ANNUAL FIGURES		8767	$8,585.32	8767	$4,311.31	$12,896.64

APPENDIX A

SOLVENT USAGE AND WASTE PRODUCTION ANALYSIS

DEPARTMENT OF LABORATORY MEDICINE, HENDERSON GENERAL HOSPITAL

CALANDAR YEAR	SOLVENT	ANNUAL USAGE (litres)	ANNUAL COSTS	WASTE QUANTITIES (litres)	DISPOSAL & HANDLING COSTS	TOTAL COSTS
1994	ETHANOL @$241.50/Drum	4410	$5,071.50	4000	$0.00	$5,071.50
1994	XYLENE @$160.30/Drum	1050	$801.50	840	$700.00	$1,501.50
1994	METHANOL @$126.35	1470	$884.45	1050	$1,050.00	$1,934.45
1994	EMPTY DRUM TRANSPORT			21 Drums	$945.00	$945.00
1994 TOTALS		6930	$6,757.45	5890	$2,695.00	$9,452.45
1995	ETHANOL @$256.20/Drum	2520	$3,074.40	2052	$0.00	$3,074.40
1995 *	XYLENE @$218.15/Drum	630	$218.15	630	$175.00	$393.15
1995	METHANOL @$216.62/Drum	1260	$1,299.72	420	$350.00	$1,649.72
1995	EMPTY DRUM TRANSPORT			12 Drums	$540.00	$540.00
1995 TOTALS (Jan.-Oct./95)		4410	$4,592.27	3102	$1,065.00	$5,657.27
1995 PROJECTED ANNUAL COSTS/USAGES						
1995	ETHANOL @$256.20/Drum	3570	$4,355.40	2634	$0.00	$4,355.40
1995 *	XYLENE @$218.15/Drum	210	$218.15	630	$175.00	$393.15
1995	METHANOL @$216.62/Drum	1260	$1,299.72	630	$525.00	$1,824.72
1995	EMPTY DRUM TRANSPORT			17 Drums	$765.00	$765.00
1995 TOTALS (Jan.-Dec./95)Projected		5040	$5,873.27	3894	$1,465.00	$7,338.27

APPENDIX B

FLOOR PLAN
SCALE N.T.S.

BARREL DESCRIPTION

CAGE 1

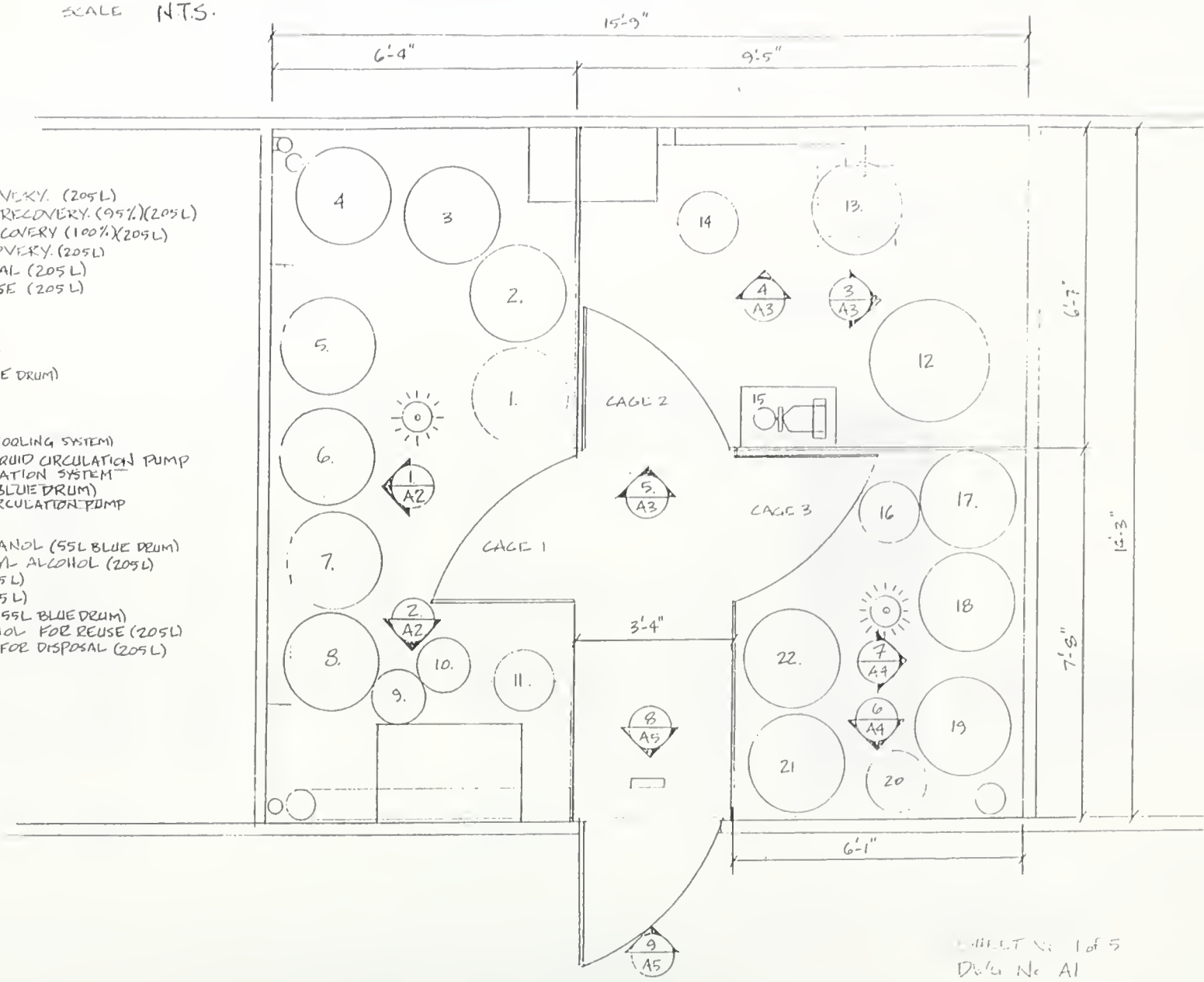
1. WASTE METHANOL FOR RECOVERY. (205L)
2. WASTE ETHYL ALCOHOL FOR RECOVERY. (95%)(205L)
3. WASTE ETHYL ALCOHOL FOR RECOVERY (100%)(205L)
4. WASTE XYLENE FOR RECOVERY. (205L)
5. WASTE XYLENE FOR DISPOSAL (205L)
6. RECLAIMED XYLENE FOR REUSE (205L)
7. METHANOL (VIRGIN)(205L)
8. VIRGIN METHANOL (205L)
9. RINSE CONTAINER (20L)
10. RINSE CONTAINER (20L)
11. RECLAIMED XYLENE (55L BLUE DRUM)

CAGE 2 (CLOSED LOOP COOLING SYSTEM)

12. COOLING TANK & IMMERSED LIQUID CIRCULATION PUMP
13. LAB MASTER SOLVENT RECLAMATION SYSTEM
14. RECLAIMED METHANOL (55 L BLUE DRUM)
15. "MERMAID" MOLECULAR SIEVE CIRCULATION PUMP

CAGE 3

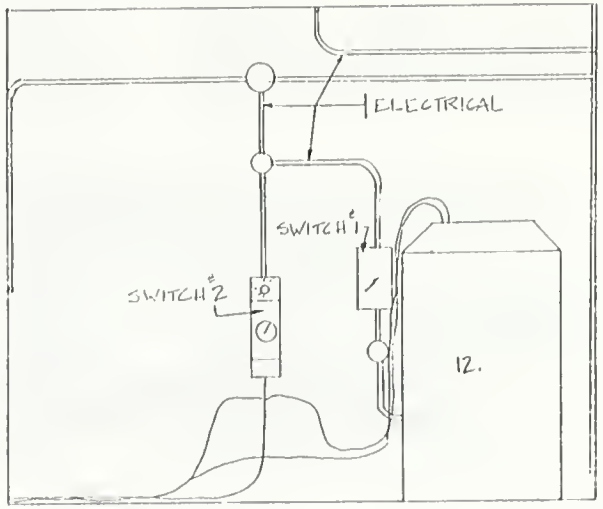
16. RECOVERED ABSOLUTE ETHANOL (55L BLUE DRUM)
17. RECOVERED ABSOLUTE ETHYL ALCOHOL (205L)
18. ETHYL ALCOHOL (VIRGIN)(205L)
19. ETHYL ALCOHOL (VIRGIN)(205L)
20. 95% RECLAIMED ETHANOL (55L BLUE DRUM)
21. RECLAIMED WASTE METHANOL FOR REUSE (205L)
22. ABSOLUTE WASTE METHANOL FOR DISPOSAL (205L)



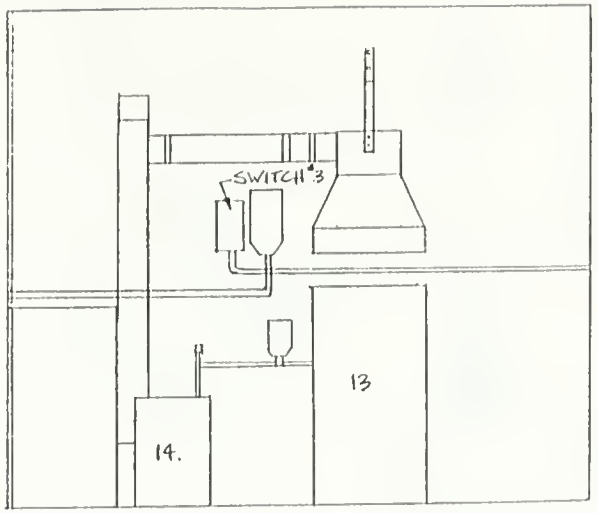
SHEET No. 1 of 5
Dwg No. A1

CAGE 2 - ELEVATIONS

SCALE: N.T.S.



3
A3



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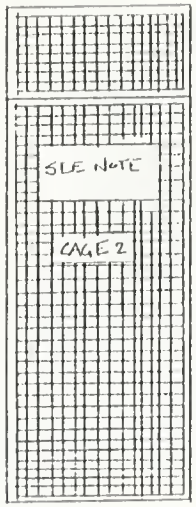


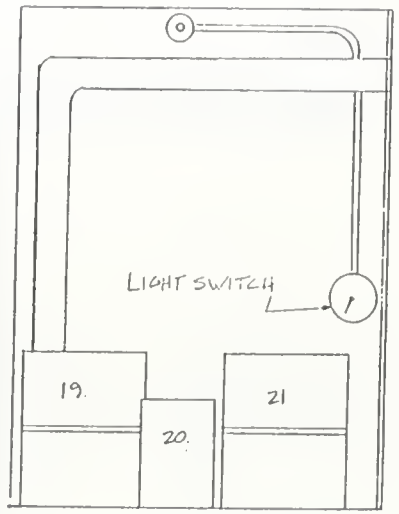
5
A3

NOTE:

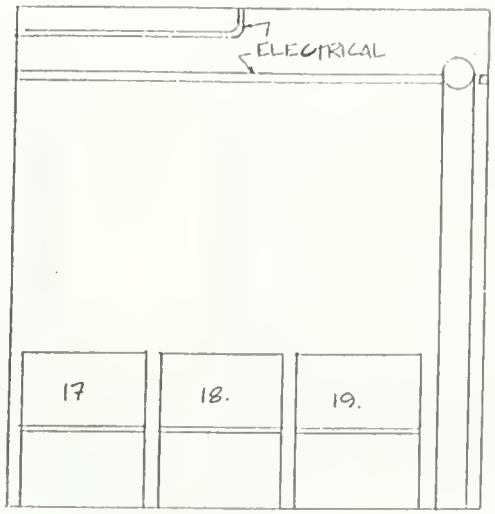
IT IS THE LAW
1. ALL DRUMS MUST BE GROUN
2. ALL PORTABLE CONTAINER MUST BE GROUNDED TO THE BEFORE POURING.

SHEET No: 3 of 5
DWG No: A3

CAGE 3 - ELEVATIONS
SCALE N.T.S.



6/A4



7/A4

SHEET No 4 of 5
DWG No 44

ENTRANCE ELEVATIONS

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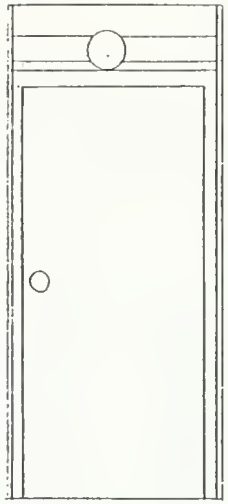
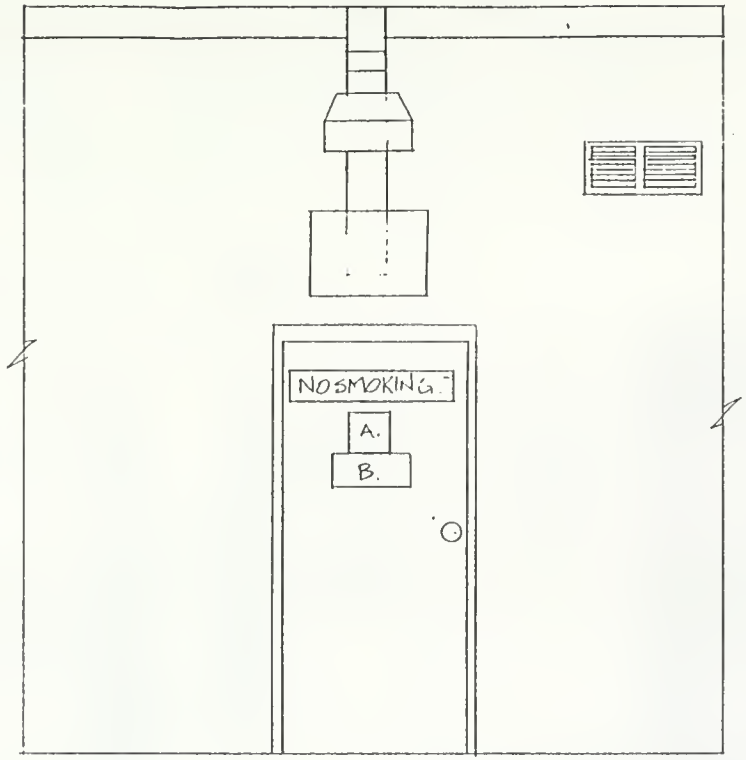


5
A5



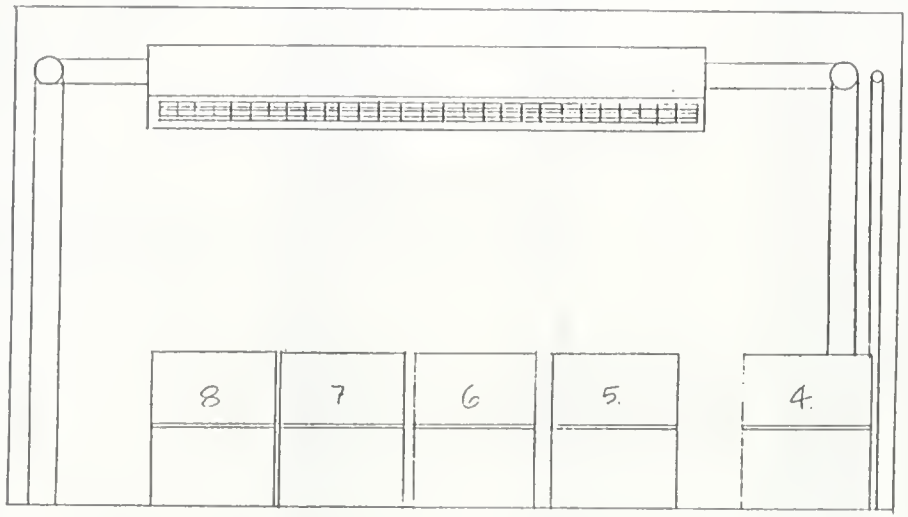
9
A5

A LIQUID AIR OF CANADA
LIQUID CARBON DIOXIDE STORAGE L
FINAL ADJUSTMENT + INSTALLATION RE

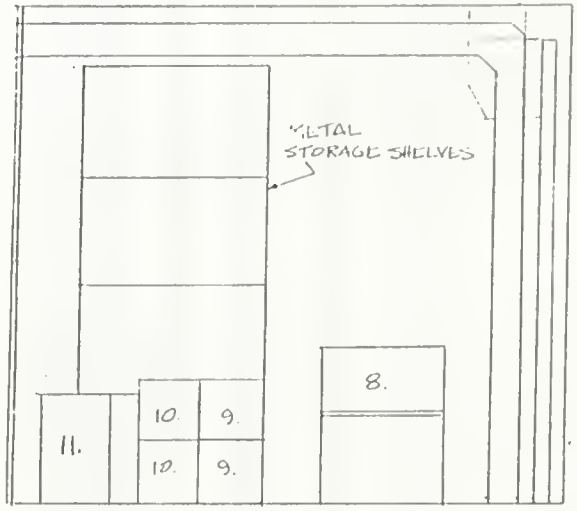
B DO NOT BLOCK
or STACK OBJECTS
AGAINST THE DOOR

SHEET No. 5 of 5
DWG No: A5

CAGE 1 ELEVATIONS
SCALE - N.T.S.



1/A2



2./A2

SHEET No 2 of 5
DWG No A2

APPENDIX C

Virgin and Reclaimed Solvent Comparison

Date: Oct. 27, 1995
By: H. Young
Report No.: XYL51027

1.0 Purpose

To analyze virgin xylene, reclaimed waste xylene, and pre-reclaimed waste xylene using gas chromatograms, and to determine the per cent ethanol present in virgin ethanol, pre-reclaimed ABS. ethanol and reclaimed ABS. ethanol

2.0 Data

See assay033.RUN, asfp008.RUN, asfp014.RUN, asfp025.RUN, assay031.RUN, and assay246.RUN.

3.0 Conclusions

Virgin Xylene G.C. plot shows ortho, meta and para isomers of xylene. Ethyl benzene at retention time 16.448, para isomer at retention time 16.663, meta isomer at 17.285 and ortho isomer at split retention time 18.737 and 18.872 . 99.3924% of the total organics is xylene.

Reclaimed Waste Xylene G.C. plot show ortho, meta and para isomers of xylene. Ethyl benzene at retention time 16.424, para isomer at retention time 17.264, meta isomer at retention time 17.264 and ortho isomer at split retention time 18.712 and 18.845. 99.3504% of the total organics is xylene.
Ethanol present at less than 0.01%.

Pre-reclaimed Waste Xylene G.C. plot shows ortho, meta and para isomers of xylene. Ethyl benzene at retention time 16.407, para isomer at retention time 16.619, meta isomer at retention time 17.243, and ortho isomer at split retention time 18.701 and 18.835. 93.4257% of total organics is xylene.
Methanol present at 0.0039%, and ethanol present at 5.9288%.

Virgin Ethanol G.C. plot shows an ethanol peak at 4.074. 99.9966% of the total organics is ethanol.

Pre-reclaimed ABS. Ethanol G.C. plot shows an ethanol peak at 4.120. 99.3767% of the total organics is ethanol.

Reclaimed ABS. Ethanol G.C. plot shows an ethanol peak at 4.004. 99.3907% of the total organics is ethanol.

4.0 Recommendations

none.

APPENDIX C

Analysis for ESBE

Date: Oct. 30, 1995
By: H. Young
Report No.: ESB51030

Results from gas chromatograms.

Sample Name	Methanol Content %	Ethanol Content %	m-Xylene & p-Xylene Content %	Ethylbenzene Content %
Virgin Xylene			84.1064%	14.7427%
Reclaimed Waste Xylene		0.0055%	83.5766%	15.1669%
Pre-reclaimed Waste Xylene	0.0039%	5.9288%	78.9856%	13.8758%
Virgin Ethanol	0.0034%	99.9966%		
Pre-reclaimed ABS Ethanol	0.1264%	99.3767%		
Reclaimed ABS Ethanol	0.1426%	99.3907%		